

Brookhaven National Laboratory
Justification for Proposed PFOS/PFOA and 1,4-Dioxane Areas of Concern
April 23, 2021

AOC 33: PFOS and PFOA

Following the 2017 detection of Per- and Polyfluoroalkyl Substances (PFAS) in three BNL water supply wells (BNL-6, BNL-10 and BNL-11), a comprehensive search of available records, documents and interviews with long-term current and former employees identified eight areas where firefighting foam had been released to the ground during the period of 1966 through 2008. BNL also analyzed Sewage Treatment Plant (STP) influent and effluent and STP groundwater monitoring wells to evaluate potential impacts from discharges of PFAS-contaminated water from the impacted supply wells. Characterization efforts have confirmed that the groundwater at the nine proposed Sub-Areas of Concern (Sub-AOCs) has been impacted by PFAS (**Figure 1**). Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) concentrations were found to exceed New York State's current 10 ng/L maximum contaminant level (MCL) at all nine of the Sub-AOCs. Results from the characterization of groundwater in eight foam release areas and STP area were presented in the *2018 BNL Groundwater Status Report* (BNL 2019). During 2019-2020, BNL conducted a comprehensive sampling of 360 on-site and off-site monitoring wells, groundwater treatment systems, as well as detailed characterizations of the PFAS plumes associated with the current firehouse and former firehouse foam training areas. These characterization efforts did not identify any additional PFAS source areas. Results from PFAS characterization efforts performed during 2020 are presented in the *Phase 4 Characterization Report* (BNL 2021a) and in the *Time Critical Removal Action Characterization Report* (BNL 2021b).

Summaries of the known history and impacts to soil and groundwater at the nine Sub-AOCs are provided below:

Sub-AOC 33A Former Bubble Chamber Experiment and Blockhouse Area

History: Due to the use of flammable scintillation fluid at the former Bubble Chamber experiment, BNL installed a high-expansion foam fire suppression system in the building that housed the experiment (former Building 960). In April 1973, BNL conducted a test of the suppression system which resulted in the release of a large volume of high-expansion foam outside of the building. There are no records on the formulation or volume of foam concentrate that was used. Available photographs show that the area surrounding the Bubble Chamber building was unpaved. Three months later, in July 1973, the fire suppression system accidentally released foam inside the Bubble Chamber building. The foam spread out of the building and onto the ground outside. The foam was washed down with water. In 1980, the foam suppression system was tested prior to its decommissioning, and available documentation indicates that the foam released during the test was directed outside. The former Bubble Chamber building was subsequently demolished.

A second high-expansion foam fire suppression system was installed in a nearby building referred to as the "Blockhouse" (former Building 965), where approximately 30,000 gallons of scintillation fluid for the Bubble Chamber experiment was stored. There are no records that the suppression system was ever activated or that foam from this system was released to the environment. The system was decommissioned in 1990, and the building was subsequently demolished.

Impacts to the Environment: Based upon groundwater monitoring results, the PFAS released in the former Bubble Chamber area continues to impact groundwater quality (**Figure 2**). PFOS and PFOA have been detected in shallow groundwater at concentrations up to 125 ng/L and 13.7 ng/L, respectively. The PFAS released in this area has impacted water quality at supply wells BNL-10 and BNL-11. The continued detection of these chemicals in groundwater indicates that residual PFAS may be present in the source area soils.

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Sub-AOC 33B Building 924 Area

History: In September 1970, high-expansion foam was released into a work trailer. This was apparently conducted to test potential fire suppression systems that could be used for the Bubble Chamber building. Although the trailer was positioned on pavement, one side of the trailer was adjacent to a soil/vegetated area. Available photographic records show that some of the foam spread into the adjacent vegetated area. There are no storm drains in the immediate area of the former trailer location, and it is likely that the foam was rinsed off the pavement and into the nearby vegetated area after the test. Although details on the foam formulation are not available, photos show that a five-gallon container of foam concentrate was used.

Impacts to the Environment: Based upon the monitoring results for temporary wells and permanent wells, the foam release continues to impact groundwater quality (**Figure 3**). In several temporary wells installed near the test area, PFOS and PFOA were detected in shallow groundwater at concentrations up to 16.3 ng/L and 7.2 ng/L, respectively. The PFAS released in this area has impacted water quality at supply wells BNL-10 and BNL-11. The continued detection of these chemicals in groundwater indicates that residual PFAS may be present in the source area soils.

Sub-AOC 33C East of Building 902

History: In September 1970, a second high-expansion foam test was conducted as part of the development effort for a fire suppression system installed at a building associated with the Bubble Chamber experiment. Photographic records show that a large volume of high-expansion foam was released from an experiment building onto a partially paved area located east of Building 902. The experiment building was subsequently demolished, and the area was backfilled with 5 to 10 feet of soil. There are no records on the formulation or volume of foam concentrate that was used. Because there are no storm water drains in the release area and the detection of PFAS in groundwater in this area, it is likely that the foam was rinsed onto the surrounding soil area after the test.

Impacts to the Environment: Based upon the monitoring results from several temporary wells, the foam released in this area continues to impact groundwater quality (**Figure 4**). PFOS and PFOA were detected in groundwater samples collected close to the water table at concentrations up to 10.7 ng/L and 5.8 ng/L, respectively. PFOS and PFOA were observed at higher concentrations in deeper samples, at concentrations up to 92.4 ng/L and 10.5 ng/L, respectively. The continued detection of these chemicals in the shallow groundwater indicates that residual PFAS may be present in the source area soils.

Sub-AOC 33D Current Firehouse

History: The Laboratory's current firehouse facility has been in use since 1986. Based upon discussions with current and former employees, firefighters routinely practiced with foam in the paved area along the north side of the firehouse, and in the adjacent grass and wooded areas to the north. Water released on the paved area is conveyed to several dry wells. A fire extinguisher training area was located to the northwest of the firehouse. As part of routine maintenance of firetruck foam systems, foam was periodically discharged on the pavement along the north side of the firehouse or into the adjacent grass and wooded areas. Foam may have also been released to floor drains located in the building's high-bay area. This floor drain system is connected to BNL's sanitary system. The last known training event at the firehouse where Class B foam was used, was in 2008. There are no available records on the foam formulations used over

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this period or the amount of foam that was released. In 2019, BNL replaced the remaining inventory of Class B foam that contained fluorosurfactants with PFAS-free foam.

Impacts to the Environment: The foam releases that occurred at the current firehouse facility have significantly impacted groundwater quality (**Figure 5**). PFOS and PFOA have been detected in shallow groundwater at concentrations up to 12,200 ng/L and 240 ng/L, respectively. The PFAS released from this area has impacted water quality and/or the operations of supply wells BNL-4 and BNL-6. The detection of high levels of these chemicals in the groundwater downgradient of the current firehouse foam training areas indicate that significant levels of residual PFAS may be present in the source area soils. PFOS and PFOA at concentrations >10 ng/L have been traced from the current firehouse approximately 2,900 feet south to the West Princeton Avenue area (BNL 2021b). As part of a Time Critical Removal Action (TCRA), BNL has designed a groundwater treatment system to remediate the high concentration (>100 ng/L) segments of the PFOS/PFOA plume. Construction of the treatment system is expected to start during the summer of 2021.

Sub-AOC 33E Former Firehouse

History: The Former Firehouse was in operation from 1947 through 1985. Photographic records indicate that firefighting foam was used at the facility as early as 1966. Based upon discussions with current and former employees, firefighters routinely practiced with foam in a training area that was located immediately west of the firehouse. The training area was an open grass/dirt field. A second, infrequently used training area was located east of the firehouse. In this unpaved area, firefighters would periodically practice extinguishing car fires using foam. Furthermore, as part of routine maintenance of firetruck foam systems, foam was periodically discharged on the pavement in front of the firehouse. There are no available records on the foam formulations used over this period or the amount of foam that was released. The Former Firehouse was demolished in March 1986. Following demolition, low level radiologically contaminated soils were excavated, and the surrounding area was regraded and seeded. These actions were documented in the OU III ROD (AOC 22). Most of the training area that was located to the west of the firehouse is presently occupied by Building 725 which was constructed in the early 1980s. It is unknown whether excavation activities resulted in the removal of PFAS contaminated soils from the construction area. Available records indicate that the former firehouse did not have floor drains. Exterior storm drains may have discharged to a drainage culvert located several hundred feet to the southwest of the firehouse. Former water supply well BNL-1 was located east of the former firehouse and was in active use until September 1986.

Impacts to the Environment: The foam releases that occurred at the former firehouse have significantly impacted groundwater quality (**Figure 6**). PFOS and PFOA have been detected in shallow groundwater at concentrations up to 5,210 ng/L and 736 ng/L, respectively. The detection of high levels of these chemicals in groundwater downgradient of the former firehouse foam training areas indicates that significant levels of residual PFAS may be present in the source area soils. PFOS and PFOA at concentrations >10 ng/L have been traced from the former firehouse facility approximately 3,000 feet to the East Princeton Avenue area (BNL 2021b). As part of a TCRA, BNL is currently has designed a groundwater treatment system to remediate the high concentration (>100 ng/L) segments of the PFOS/PFOA plume. Construction of the treatment system is expected to start during the summer of 2021.

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Sub-AOC 33F Major Petroleum Facility

History: Available records indicate that in September 1986, low-expansion firefighting foam was used during a firefighting training exercise at the Major Petroleum Facility (MPF), within the containment berm of former above ground petroleum storage tank 611A. The recent detection of PFAS in most of the MPF facility surveillance wells indicates that training with foam is likely to have occurred in other areas of the MPF as well. There are no records on the foam formulation or the amount that was used during the training. BNL's current containment berms are configured to allow for controlled releases of collected rainwater to the sanitary system.

Impacts to the Environment: The foam releases that occurred at the MPF area have impacted groundwater quality. During 2018, PFOS and PFOA were detected in shallow groundwater downgradient of former storage tank 611A at concentrations up to 34 ng/L and 15.9 ng/L, respectively. Results from monitoring conducted during 2020 indicates that PFOS and PFOA are present throughout the MPF area (**Figure 7**). The continued detection of these chemicals in groundwater downgradient of the MPF indicates that residual PFAS may be present in the source area soils.

Sub-AOC 33G Building 526 Area

History: In the early 1970s, a high-expansion foam suppression system was installed on the roof of Building 526, apparently due to the use of flammable materials in one of the experimental areas of the building. Records indicate that the system was taken out of service in 1980. There are no records that indicate the system was ever activated, or that foam was released to the surrounding environment during testing or servicing.

Impacts to the Environment: Although there are no documented releases of foam at Building 526, PFOS and PFOA have been detected in shallow groundwater at concentrations up to 11.3 ng/L and 41.7 ng/L, respectively (**Figure 8**). The detection of PFOS and PFOA in groundwater downgradient of Building 526 indicates that residual PFAS may be present in the source area soils.

Sub-AOC 33H Recreation Center Area

History: Documents show that there were at least two releases of high-expansion foam in the Recreation Center area. In 1978, foam was released to the paved area south of the Recreation Center, and in 1980 foam was released to a grass field to the northeast of the Recreation Center. In both areas, it is likely that the foam was hosed down at the end of the day. In grassy areas, the water would have infiltrated into the soil. However, in the paved area it is possible that most of the water would have entered one of the nearby stormwater drains. Stormwater from this area is conveyed by an underground pipe to a drainage area located approximately 450 feet to the northeast of the Recreation Center. Based upon recollections of several firefighters, additional foam releases may have occurred in this area during the 1970s and 1980s. Although there are no records on foam formulations or volumes used in this area, several firefighters recall that protein-based (biodegradable) foam may have been used.

Impacts to the Environment: Foam releases that occurred near the Recreation Center have impacted groundwater quality. PFOS and PFOA have been detected in shallow groundwater at concentrations up to 12.8 ng/L and 10.1 ng/L, respectively (**Figure 9**). In the stormwater discharge area to the east, PFOS and PFOA have been detected in shallow groundwater at concentrations up to 9.9 ng/L and 28 ng/L, respectively. Preliminary analysis of source area soils detected low levels of residual PFAS. PFOS and

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PFOA were detected in the soils up to 1.55 ng/g and 0.39 ng/g, respectively. Although these concentrations are below the current NYS soil guidance values for “Residential” use of 6.6 ng/L for PFOS and 8.8 ng/g for PFOA, the maximum PFOS concentration in soil was slightly above the 1.1 ng/g guidance values for “Protection of Groundwater.”

Sub-AOC 33I Sewage Treatment Plant (STP)

History: The STP processes sanitary wastewater from BNL research and support facilities and has been in continuous operation since 1947. Until October 2014, treated effluent from the STP was discharged to the Peconic River under a State Pollutant Discharge Elimination System (SPDES) permit. As part of the treatment process, water passed through sand filter beds before being collected in an underdrain collection system and was then discharged to the river. Approximately 20 percent of the water discharged to the sand filter beds bypassed the underdrain system and recharged directly to groundwater. The water discharged to the river oftentimes infiltrated the riverbed and into the Upper Glacial aquifer before reaching the site boundary. Starting in October 2014, treated wastewater discharges were redirected to nearby groundwater recharge basins (SPDES Outfall 001).

Impacts to the Environment: PFAS that entered the BNL sanitary system have impacted groundwater quality at the STP and in downgradient areas (**Figure 10**). During 2020, PFOS and PFOA were detected in filter bed areas monitoring wells at concentrations up to 152 ng/L and 39 ng/L, respectively. The PFAS may have entered the sanitary system by: 1) PFAS contaminated potable water used for sanitation; 2) firefighting foam released to the floor drain system at the current firehouse; and 3) possibly from controlled water discharges from the MPF berms where firefighter training with foam may have occurred. The detection of PFOS and PFOA in groundwater near the former filter beds indicates that residual PFAS may be present in the source area soils.

AOC 34: 1,4-Dioxane

1,4-Dioxane was used as a stabilizer for chlorinated solvents such as 1,1,1-trichloroethane (TCA), and is present in some paint strippers, greases, waxes, laundry detergents, shampoos, and personal care products. BNL has been actively remediating TCA contaminated groundwater since the 1980s. 1,4-Dioxane has been detected in on-site and off-site monitoring wells and groundwater treatment systems at concentrations that exceed New York State’s 1.0 µg/L MCL.

History: TCA has impacted groundwater quality in several areas across the BNL site. Potential sources of the 1,4-dioxane include historical TCA spills, discharges to cesspools that were located in the central areas of the site (AOC 13), spills at the BNL Paint Shop (AOC 7), spills at the vehicle maintenance facilities, the Current Landfill (AOC 3), and spills at the Former Hazardous Waste Management Facility (AOC 1). In the mid-1980s, TCA was detected in several BNL water supply wells: former BNL-2, BNL-4, BNL-10, BNL-11 and BNL-12, and former Medical Research Reactor cooling water supply well BNL-105 at concentrations above the 5 µg/L MCL. TCA is not currently detected in BNL’s active water supply wells, and in the central areas of the BNL site TCA concentrations have dropped to nearly non-detectable levels. TCA was or continues to be a component of several on-site and off-site VOC plumes (e.g., OU I South Boundary, OU III Western South Boundary, OU III Middle Road and Southern Boundary, Industrial Park, LIPA/Airport, North Street, North Street East, and the former OU V plume).

Impacts to the Environment: In 2017, BNL began testing for 1,4-dioxane in select on-site and off-site monitoring wells and treatment systems that have or had detectable levels of TCA. 1,4-Dioxane was

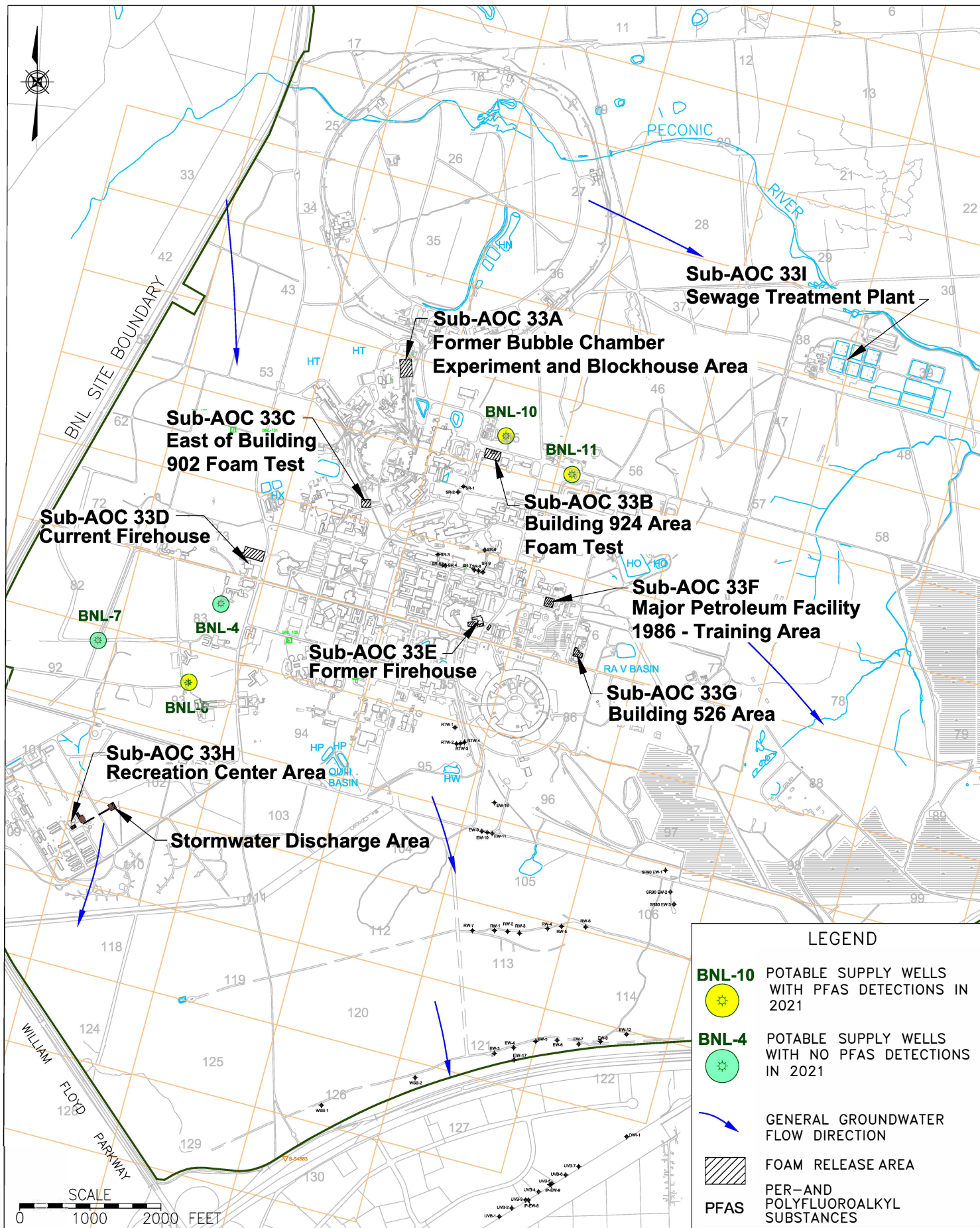
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detected in several on-site and off-site monitoring wells and groundwater treatment systems, with a maximum concentration of 18.6 µg/L in an OU III Industrial Park monitoring well. The 1,4-dioxane monitoring results for 2017 and 2019 were summarized in the *2018 BNL Groundwater Status Report* (BNL 2019). A more comprehensive characterization of 1,4-dioxane using approximately 360 on-site and off-site monitoring wells, 35 temporary wells, and groundwater treatment system extraction wells was completed in 2020. Whereas 1,4-dioxane is non-detectable or at concentrations <1.0 µg/L near the former source areas located in the central area of the BNL site, there were more widespread detections of 1,4-dioxane at concentrations ranging between 1.0 µg/L and 24 µg/L in the southern half of the BNL site and in several off-site areas (**Figures 11 and 12**). 1,4-Dioxane has not been detected in any of BNL's water supply wells at concentrations above the 1.0 µg/L MCL. The results of the comprehensive characterization efforts are provided in the *Phase 4 Characterization Report* (BNL 2021a) and the *Time Critical Removal Action Characterization Report* (BNL 2021b).

References:

- BNL 2019. 2018 Site Environmental Report, Volume 2, Groundwater Status Report. Brookhaven National Laboratory, Upton, New York. June 2019.
- BNL 2021a. Phase 4 Characterization Report, Per- and Polyfluoroalkyl Substances (PFAS) and 1,4-Dioxane in On-Site and Off-Site Monitoring Wells, Extraction Wells and Treatment Systems. Brookhaven National Laboratory, Upton, New York. February 22, 2021.
- BNL 2021b. Time Critical Removal Action for Per- and Polyfluoroalkyl Substances (PFAS) in Groundwater Downgradient of the Current and Former Firehouse Facilities, Plume Characterization Report. Brookhaven National Laboratory, Upton, New York. April 6, 2021.
- NYSDEC 2021. Sampling, Analysis and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs. January 2021.

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ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

LOCATIONS OF
AOC 33 SUB-AREAS OF CONCERN

DWN:

AJZ

VT: HZ.:

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DATE:

04/13/21

PROJECT NO.:

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CHKD:

WRD

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DEP

REV.:

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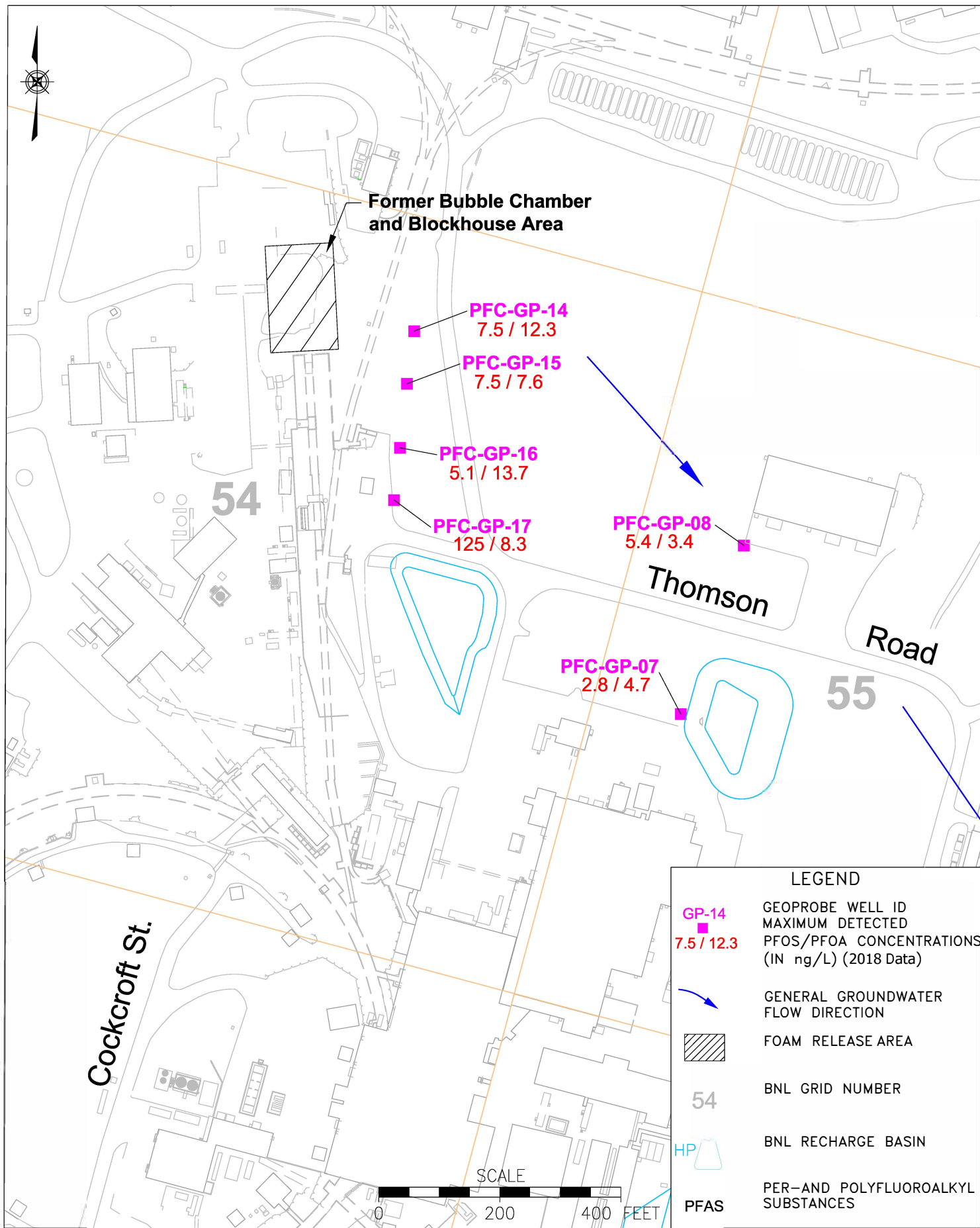
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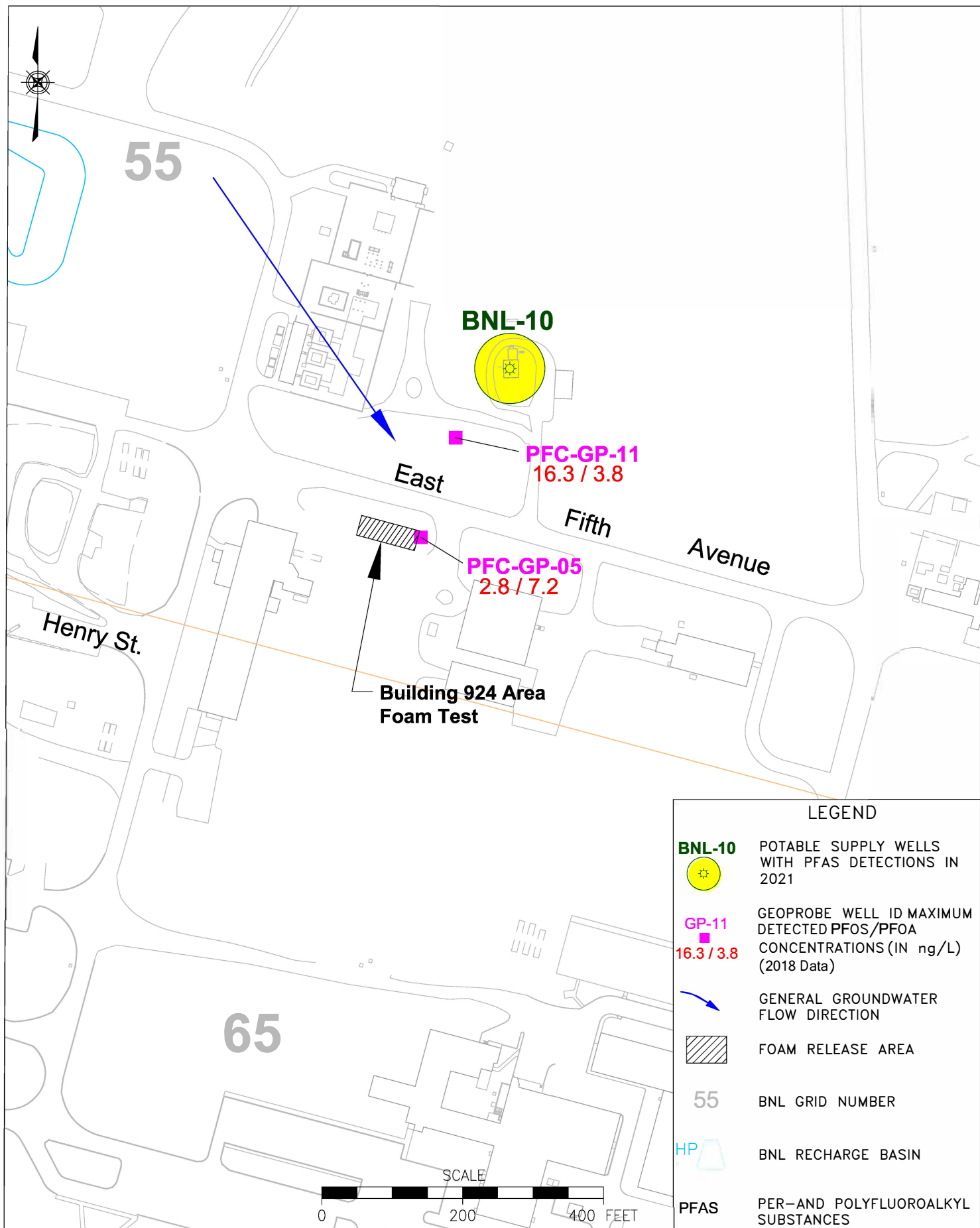
FIGURE NO.:

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LEGEND

BNL-10



POTABLE SUPPLY WELLS
WITH PFAS DETECTIONS IN
2021

GP-11



GEOPROBE WELL ID MAXIMUM
DETECTED PFOS/PFOA
CONCENTRATIONS (IN ng/L)
(2018 Data)

16.3 / 3.8



GENERAL GROUNDWATER
FLOW DIRECTION



FOAM RELEASE AREA

55

BNL GRID NUMBER



BNL RECHARGE BASIN

PFAS

PER-AND POLYFLUOROALKYL
SUBSTANCES

SCALE

0 200 400 FEET

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TITLE:

SUB-AOC 33B
BUILDING 924 AREA

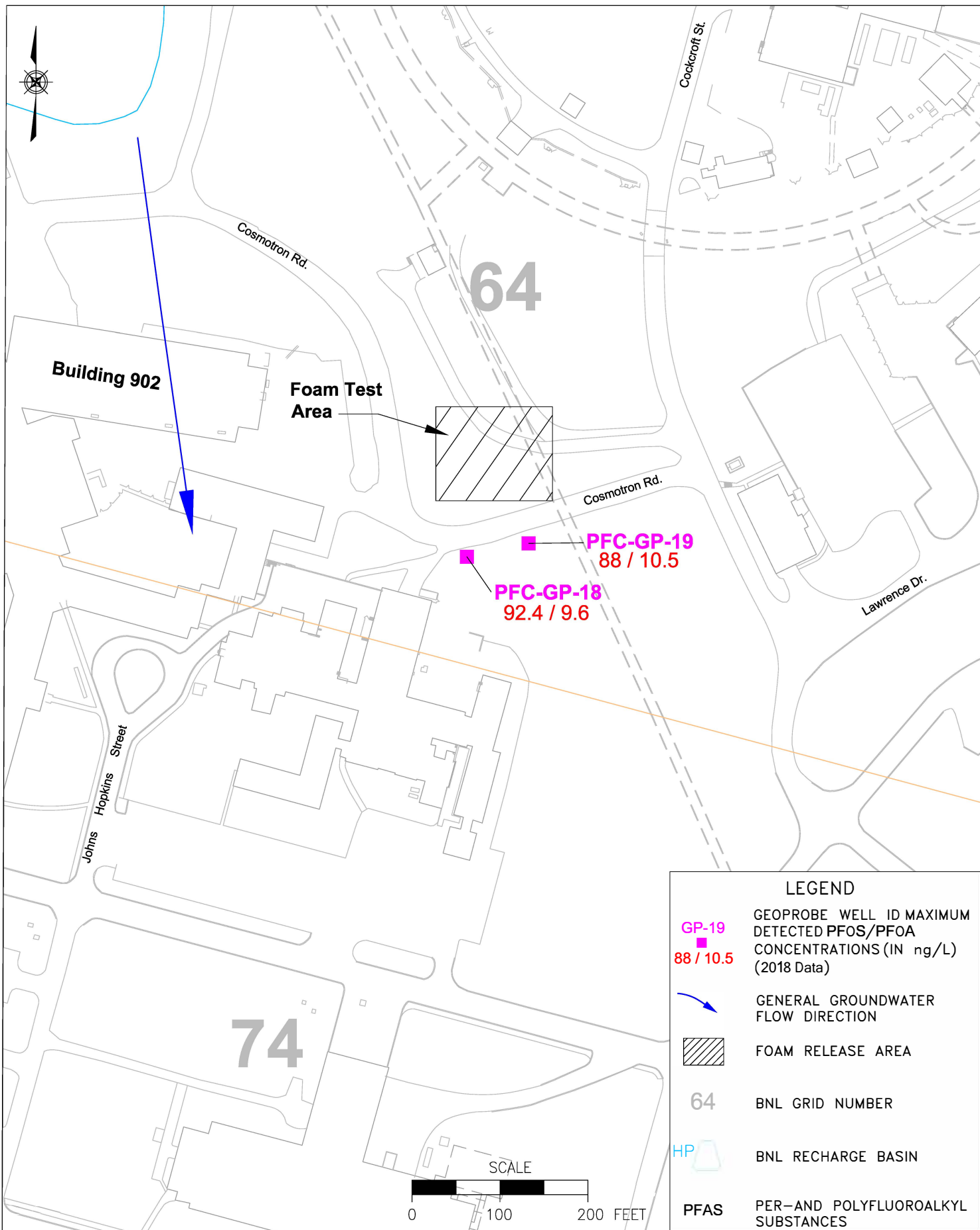
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CHKD: WRD APPD: DEP REV.: NOTES: -

FIGURE NO.:

3

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PROTECTION DIVISION

TITLE:

SUB-AOC 33C
BUILDING 902 AREA

DWN: VT: HZ.: DATE: PROJECT NO.:

AJZ

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04/13/21

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CHKD: APPD: REV.: NOTES:

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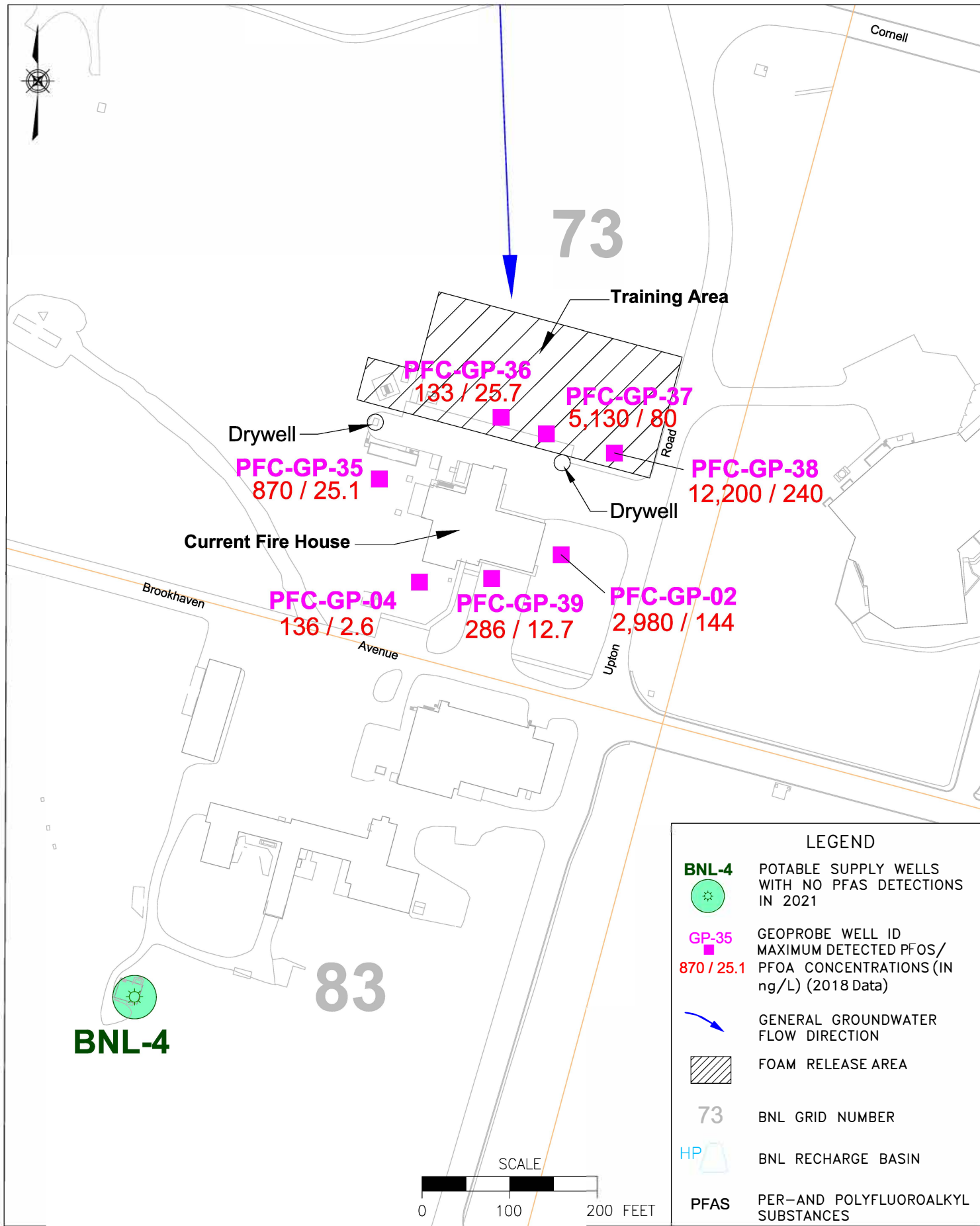
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



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FIGURE NO.:

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LEGEND	
	BNL-4 POTABLE SUPPLY WELLS WITH NO PFAS DETECTIONS IN 2021
	GP-35 GEOPROBE WELL ID
	MAXIMUM DETECTED PFOS/ PFOA CONCENTRATIONS (IN ng/L) (2018 Data)
	GENERAL GROUNDWATER FLOW DIRECTION
	FOAM RELEASE AREA
	BNL GRID NUMBER
	BNL RECHARGE BASIN
	PER-AND POLYFLUOROALKYL SUBSTANCES

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ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

SUB-AOC 33D
CURRENT FIREHOUSE AREA

DWN: VT: HZ.: DATE: PROJECT NO.:

AJZ

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04/13/21

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WRD

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REV.:

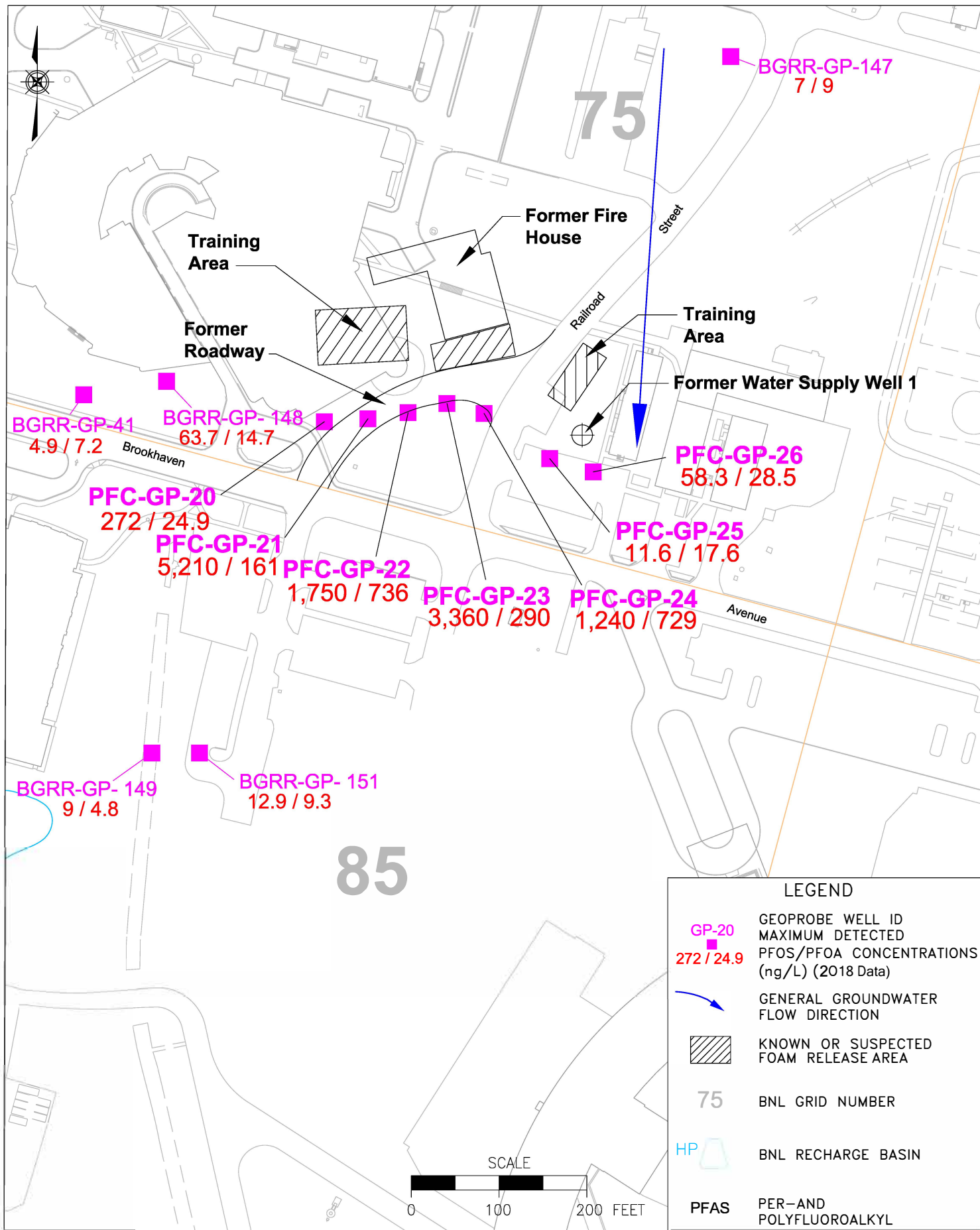
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FIGURE NO.:

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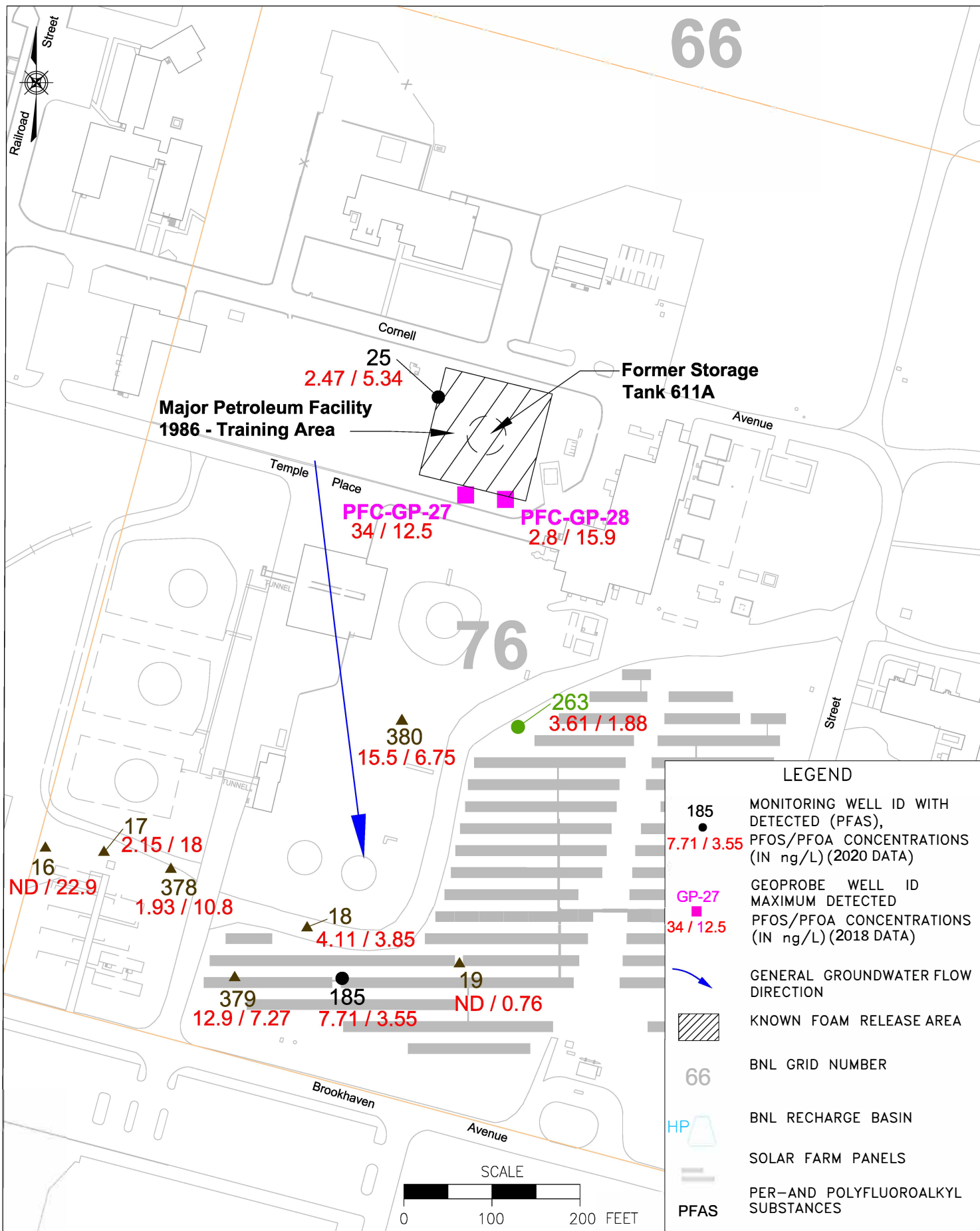
SUB-AOC 33E
FORMER FIREHOUSE AREA

DWN: AJZ	VT.HZ.: -	DATE: 04/13/21	PROJECT NO.: -
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FIGURE NO.:

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PROTECTION DIVISION

TITLE:

SUB-AOC 33F
MAJOR PETROLEUM FACILITY AREA

DWN:

AJZ

VT: HZ.:

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DATE:

04/13/21

PROJECT NO.:

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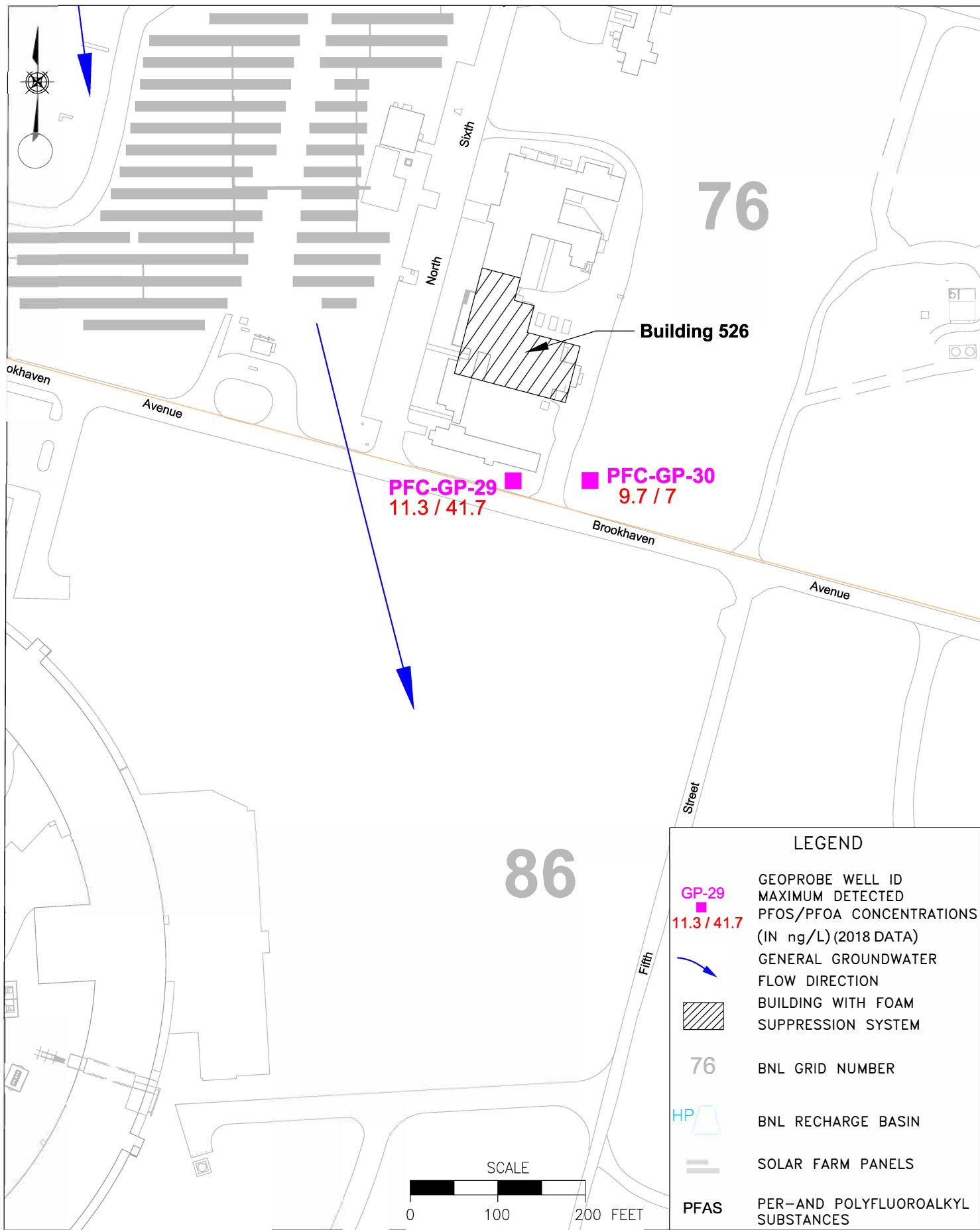
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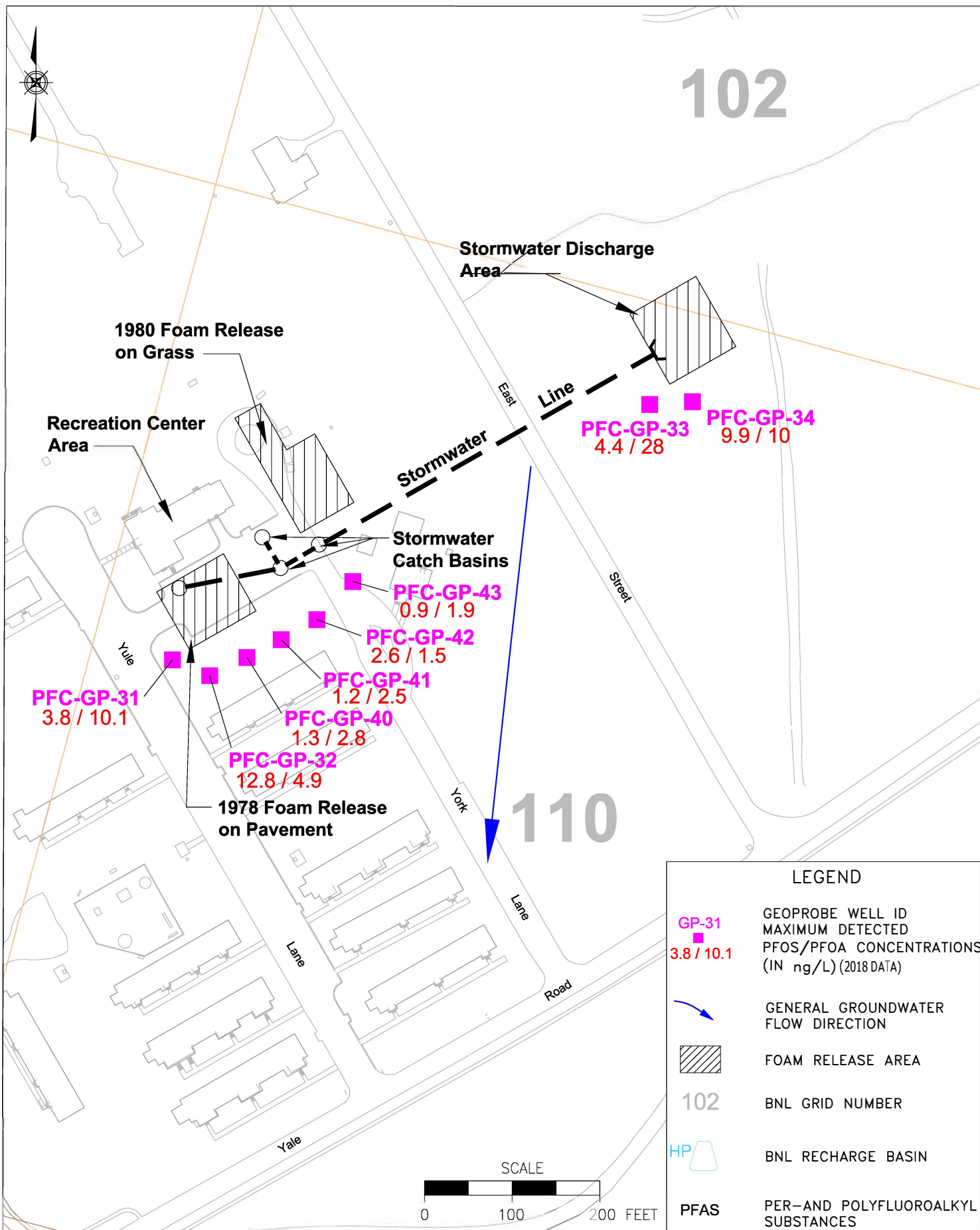
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LEGEND	
■ GP-31 3.8 / 10.1	GEOPROBE WELL ID MAXIMUM DETECTED PFOS/PFOA CONCENTRATIONS (IN ng/L) (2018 DATA)
→	GENERAL GROUNDWATER FLOW DIRECTION
	FOAM RELEASE AREA
102	BNL GRID NUMBER
HP 	BNL RECHARGE BASIN
PFAS	PER-AND POLYFLUOROALKYL SUBSTANCES

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